

containing nitrate, phosphate and soil extract, a less increase in the nitrate, phosphate, ferri-ligno protein and manganese] and the least, but none the less considerable one, in the nitrate and phosphate culture.

R. S. W.

H. Kuenen. "Geological Results. Pt. 2. Geology of Coral Reefs." "Snellius" Exped., Vol. 5. Utrecht, 1933.

Our author is quite frank, stating that he "spent about 40 days studying reefs and reef formations scattered all over the eastern part of the Dutch East Indies." Some 31 places were visited so that his work was of the nature of a rapid reconnaissance and his charts, "simple compass and pacing surveys", show few soundings. His own observations appear to have been confined to islands and coasts and are thoroughly interesting. These entitle him to draw his conclusions as to the movements of land in respect to the sea level and as to the phenomena of the reef surface — and all careful working founded on a researcher's own observations is valuable. But our author goes further and presents a chapter "On the Formation of Atolls" which is the consideration merely of charts (to which are perhaps added the observations of others) as he himself states. I am constrained to refer to this, for my views are frequently mentioned and I cannot regard this chapter, the only one which deals with matters of importance to the question of coral reef formation, as of greater value than if written by a geologist who has never seen a coral reef. The observations made by many observers in many parts of the world are so long-continued, detailed and careful that the deductions from them cannot be skimmed in a light style. The charts here given from the East Indies are not reproduced with sufficient detail to make the topography of our author's atolls comparable with that of several well-surveyed oceanic atolls. Perhaps I am misunderstanding and our author only wishes to apply his remarks to the East Indies; and this I suspect to be the case, since I do not find any works of Murray, Agassiz and above all Dana even referred to. The theory of subsidence was applied by Darwin to *all* barrier reefs and atolls but what geologist would now claim for it such a world wide applicability? For my part while I think the foundations of many atolls have subsided, I claim that there are agencies at work to-day on coral banks that *can* transform such into atolls without movement of the earth's crust below. I do not go further and the author's *own* observations do not traverse a single one of my contentions.

Turning now to Dr. Kuenen's article, there are recognised three small negative oceanic movements of 4—5 m., $1\frac{1}{2}$ —2 m. and $\frac{1}{2}$ —1 m., seen in three sets of levels. He is cautious but he evidently believes that these negative movements are as universal in the East Indies as I showed them to be in the Maldives in 1902. Indeed, the coral islands of these two very diverse regions seem to be remarkably similar in their coastal losses in exposed situations, in the surface structure of their reefs and in their islets washed up as banks in protected situations. In effect, it would appear that the East Indian low coral islets and their reefs are in no essentials different from those of the rest of the Indo-Pacific. Abrasion of elevated reefs on their coasts is believed to be the result of solution by the surface layers of sea water. It is pointed out that solution does not extend below low tide level, but surely on an exposed coast there is little or no surface down to 20 fathoms or so that is not covered by living organisms, through the flesh of which solution could not act. In protected situations, as in the East

Indies or as in Fiji, my observations, on which I described in 1898 the eating away of elevated reefs in many situations, cannot be due to the cutting of the waves, using carried particles, — and we cordially endorse our author's view that the matter should be experimentally investigated in the field; it may well be that the undercutting is due to solution and abrasion, both produced by organisms acting upon and in the rock, limestones being much affected as compared to volcanic rocks. The influence of larger changes of level on reef development is also discussed. There is plenty of evidence of elevation in the formation of terraces, etc., but we had hoped also to find the question of the embayed valleys of Davis considered as evidence for subsidence, a geological question that worries many students of reef formation.

The reef-flats vary greatly on different coral banks, but why there is a lesser dominance of dense calcareous algae on the seaward edges of the East Indian reefs is not clear. The rate of growth of corals is well known experimentally, but the rate of growth of Lithothamnionaceae has not been established; it cannot be assumed to be slow. The formation of shallow rimmed pools on the reef flat is correlated with the toothed seaward edges of the reef. These latter as elsewhere are supposed to be the mode of growth of the reef seawards, while its surface pools are formed by solution. The use of the term "boulder" is puzzling, since it implies transport. Many of the "boulders" of Pelokang "grew on the spot" and retain their "original upright position"; the "boulder rampart" is the pinnacled remains of a reef slightly exposed by the lowering of water level. Similar structures, as Agassiz's photographs clearly show, tend to be present on most Indo-Pacific atolls; they are, as in the East Indies, "fossil formations" and their larger masses are surely what are often termed "horses". For want of a better term I called in 1898 a zone of such to seaward of the islands of Funafuti the "rough zone", employing the term "boulder zone" for an area of loose fragments torn off the reef, piled up by the seas in a line a short distance within the seaward edge of the reef-flat. At any rate the author and I agree to confine the term "negroheads" to large masses of rock, pitched on to the reef by the waves. The formation of beach sandstone is next considered, and it is deemed to be due to "evaporation of the sea water during low tide. The stratification, however, is not explained." We wish that Dr. Kuennen had cut sections through these formations and had examined them closer, even using rock sections. I regret that I never did so, and I only know their gross morphology in a very few places. I don't agree as to the necessity of evaporation to explain cementation, believing it to be largely a surface tension phenomenon, on which view stratification is implied; possibly Dr. Kuennen has brought home specimens on which he could test this view?

The formation of atolls is discussed, but it is considered quite apart from barrier reefs, an impossible separation in considering the theory of subsidence. The curious formation of the Toekang Besi Group is satisfactorily explained by the aid of an admirably contoured chart. The submarine slopes off East Indian atolls seem to be concave, but our author promises us a more extended report on the bathymetrical results of the expedition, and this will doubtless include slopes off many volcanic islands. Of the atolls most crown submarine ridges, and the relations of their foundations to currents, which sweep the bottom clean to below 100 fathoms, suggest subsidence as the best explanation of their formation; this quite new idea might well apply to many oceanic banks. Then follows a

consideration of interesting, submarine atoll-shaped banks, a close study of which would obviously be of great interest. As to the question of lagoon-formation Dr. K u e n e n honours me. Where is his evidence that "the solvent action is limited between the tidal range" — the action of the sea "sawing" into limestone is not solution — and that "a gradual filling up appears to be the general rule for lagoons". It is not in his text, nor can I find on what he bases this statement; it is quite opposed to Darwin's view. He further remarks that "it is surprising that this results in horizontal lagoon bottoms", while I contend that such floors are impossible in lagoons that are filling up as suggested. I considered solution "to be largely a biological phenomenon due both to organic decay and to the chemical action of the ever present boring organisms". In effect, Dr. K u e n e n's views on the purely physical side are not accompanied by evidence upsetting the conclusion which my collected evidence impelled me to reach that "the building and shaping of (oceanic) atolls can be explained on the basis of the chemical, physical and biological forces, both constructive and destructive, still in action in these oceans" (*Coral Reefs and Atolls*, p. 142. 1931). We hope that fate will send Dr. K u e n e n again to the East Indies to make an intensive examination of coral reefs; I feel confident that such a visit would be a great scientific success.

J. Stanley Gardiner.

S. V. Segerstråle. "Studien über die Bodentierwelt in südfinnländischen Küstengewässern." Soc. Sci. Fennica, Comm. Biol. IV, 8 und 9. Helsingfors, 1933.

In 1911 C. G. J o h. P e t e r s e n and S. E k m a n published their well-known papers on new instruments for quantitative investigation of the bottom fauna in Danish waters and in Swedish fresh waters, since when an important literature has appeared on results of investigations undertaken by means of these quantitative bottom samplers. In particular, A l m, N a u m a n n and L u n d b e c k have used them for freshwater investigations; as regards the sea D a v i s has worked in the western North Sea, S t e p h e n in the northern North Sea, F o r d in the English Channel region, H a g m e i e r in the southern North Sea, T h u l i n and H e s s l e in the southern Baltic, S p ä r c k at Iceland and the Faroes, Z e n k e w i t c h in the White Sea and T h o r s o n off the eastern coast of Greenland.

The work under review is the first report on quantitative investigations of the bottom fauna made by means of the bottom sampler in *Finnish* waters; it appears as an introduction to a series of coming reports and consists of two parts, the first of which describes the area of investigation, technique, and material, while the second part gives a survey of the animal life of the sea bottom, with special reference to production.

The major part of the investigations made during the years 1922—23 and 1926—32 relates to the neighbourhood of the zoological station at *Tvärminne*, at the south-western extremity of Finland; the rest were made near *Pellinge*, in the middle of the south coast. The object was to survey the conditions of production on the sea bottom, and to study the ecology and biology of the more important bottom-living animals.

The greatest depth in the area investigated is 41 m. The nature of the bottom varies between hard sand and soft organic detritus ("Gyttja", "Mudd"). The mean temperature of the sea during the years 1927—32 varied at one station in the *Tvärminne* district (depth 3 m.) between 6.2° and 8.1° C., and at another (30 m.) between 3.0° and 4.9°. The maximum